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# The Effect of Interactive CD-ROM/Digitized Audio Courseware on Reading Among Low-Literate Adults

## BACKGROUND

The need for effective instructional programs for adult learners is widely recognized, particularly in terms of teaching basic reading and literacy skills. In this vein, there appears to be a natural fit between this enormous national problem and the application of computer-assisted instruction. While several computer-assisted literacy programs for adult learners have been developed, virtually no scientific evaluations of them are available. Of the handful of studies cited in Rachal's (1993) review of the literature, reports were limited to *Dissertation Abstracts* and ERIC documents, and most lacked adequate control over their research designs.

Examination of available reports reveals mixed results in reading achievement for CAI. Several have reported no statistical difference between CAI and traditional literacy instruction. For example, Nurss (1989) administered an average of 100 hours of literacy instruction over the course of eight months to nonreading Adult Basic Education (ABE) students. Eleven control subjects improved .71 of a grade level on the Tests of Adult Basic Education (TABE), while 42 experimental subjects using CAI improved .34 of a grade level (n.s.). In a second study, Wangberg, Meisner, and Busick

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(1985) administered 22 hours of instruction to ABE students. Eleven control subjects used traditional instruction, while 10 experimental subjects used the Language Experience Approach software. While the experimental group showed no gain in reading performance, the controls' average gain was one grade level (n.s.).

Other studies have reported significant difference between CAI and traditional literacy instruction for adult learners. For example, Park (1990) randomly assigned adults reading at or below the third grade level to either a control group that utilized individualized instruction or an experimental group that used half individualized instruction and half CAI (with a variety of software). The 17 CAI subjects made no advance on the Gates-MacGinitie Reading Test, but the 15 control subjects gained .64 of a grade level. In contrast, Tobin (1986) provided a single 50-minute session of vocabulary instruction, and reported significantly higher achievement for CAI than for non-CAI groups.

These studies typify those available for CAI literacy instruction for adult learners, and they underscore a number of design shortcomings identified by Rachal (1993). These include variable treatment lengths, small sample sizes, subject attrition, and infrequent use of pre- and posttesting. In addition, both Gresham (1986) and Nurss (1989) have noted the problem of inadequate typing skills among adult learners in being able to manipulate computer software. The two studies reported here address each of these problems, and taken together, they provide better control over the assessment of a CAI literacy program than those previously reported. Traditional reading programs for low- and non-literate adults often rely extensively on reading texts and workbooks cloned from elementary schools. Obvious differences in maturity, needs, general knowledge, experience, motivation, and interest between children and adults may be acknowledged as important, but they are still subordinated to the more immediately compelling issue of teaching simple vocabulary and reading skills to low-literate adults. Consequently, the assumption underlying such an approach is that if an adult is capable of reading at, say, the second-grade level, then reading material used in second (and possibly) third grade provides an educationally appropriate curriculum.

Project READY (Reading to Educate And Develop Yourself) was

motivated by an interest in developing an adult literacy course with content matched to the needs of adult learners. To be both educationally and cost effective, the program had to incorporate new technologies by integrating interactive CD-ROM and digital audio. As conceived and developed, the READY Course has the following theoretical advantages over more traditional classroom reading instruction for adults: (a) improved individualization, (b) interactivity, (c) high adult interest level topics, and (d) digitized audio support.

## DEVELOPMENT OF THE READY COURSE

The READY Course is comprised of ten multimedia reading instruction modules designed for adults functioning between the fourth- and ninth-grade reading levels. As shown below, modules encompass topics of interest to adults and provide them with practical information covering consumer, health, and citizenship issues.

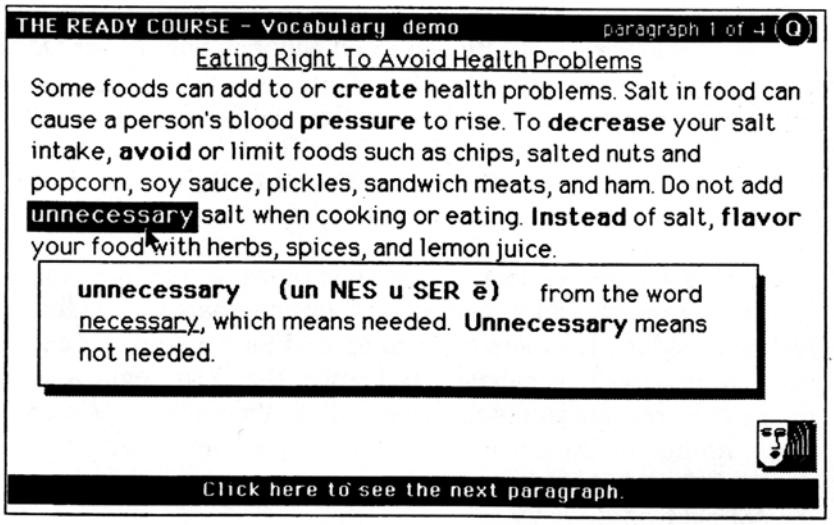
READY Course Topics:
- Tetanus
- Heart Attacks
- Eating Right To Avoid Health Problems
- Buying A Used Car
- Saving Money with Generic Drugs
- Buying Good Nutrition with Fewer Dollars
- Buy Now, Pay Later–Using Credit
- Rights and Responsibilities Of Renters
- Say What You Think by Voting
- What You Should Do If You Are in a Car Accident

READY Course students choose one of the 10 module topics to start the program, which begins with setting goals for reading the selected module. Learners proceed to read the module and explore new vocabulary. If vocabulary is known, they can begin to apply higher level reading comprehension skills to the module. As students work through additional READY Course modules, their ability to apply practiced skills becomes increasingly automatic and part of the normal reading process.

Figure 1 shows a sample paragraph from the module "Eating Right To Avoid Health Problems." The vocabulary words are highlighted in bold print. Students used a mouse to click on any bold word to see a pronunciation key and the definition of the word. In fact, the mouse made the READY Course highly interactive, with students controlling both the pace of the instruction as well as the amount of help required to understand the text. Note that the use of a mouse to control the software helps students overcome problems with inadequate keyboard skills (e.g., Gresham, 1986; Nurss, 1989). On the sample screen, the word *unnecessary* has been highlighted and selected with the mouse. The pronunciation key and definition are in a box below the paragraph. In the lower right hand corner is an icon which can be clicked to hear, via digitized audio, the pronunciation and definition of the vocabulary term. Students may select pronunciation and definitions of up to 30 words for each module. Audio directions are also available for each of the exercises.

Once an article's content is understood, students use the content to learn more advanced skills such as scanning, organizing and summarizing. Each module contains seven lessons which provide

FIGURE 1. Sample screen from READY courseware.



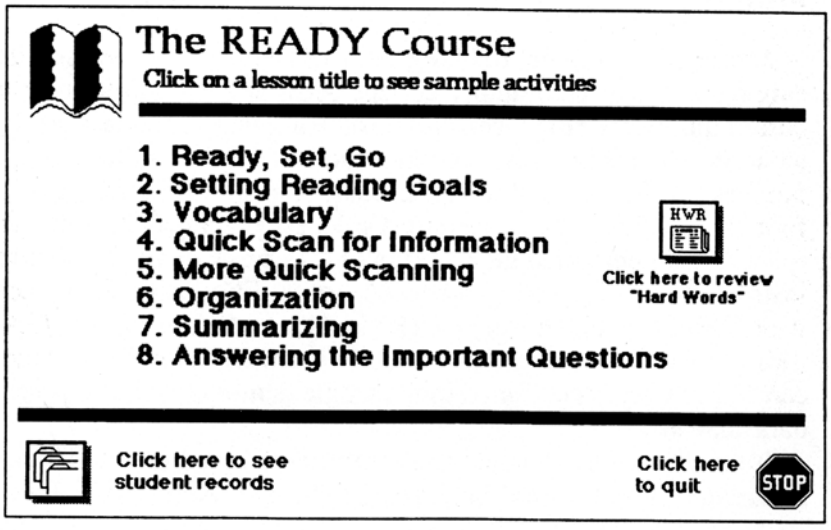
instructional activities designed to improve the following reading skills:

1. Setting Reading Goals
2. Vocabulary Development
3. Scanning for Information
4. Making First Level Inferences
5. Organizing Information
6. Summarizing Information
7. Answering Comprehension Questions

Figure 2 shows the READY Course menu students use to select activities for any given lesson. The students use the mouse to select a topic, and their progress is recorded in individualized student record files.

One of the most important features of the READY Course is its use of digital audio to produce high quality sound. A human voice was recorded and digitized so it could be stored on CD-ROM as part of the computer program. READY Course students listened through headphones plugged into the CD-ROM drive. Within the course,

FIGURE 2. Sample menu screen from READY courseware.



audio is available (a) when the four paragraphs of text are first introduced, (b) during the vocabulary development exercises, and (c) if a student chooses to hear the spoken directions for each of the exercises. In addition to instructional content, the READY Course has a built-in course management and student tracking system. The tracking system archives student scores (up to 105 per module) and elapsed time on task by module and by activity. Individual progress records are compiled automatically, and the system notifies learners about which modules and activities have been completed.

The READY Course is available on CD-ROM in both Mac and PC versions. It was developed for PCs using the 10 Core authoring system and for the Mac using Authorware for the Mac. While the READY Course was being developed, user-based formative evaluation was conducted and utilized in improving the courseware. The remainder of this paper is devoted to two independent summative evaluations of the READY Course. Study 1 describes the results of an initial field test with a single sample, while Study 2 the following year incorporated a pre- and posttest experimental and control group design to validate the results of the first study.

## STUDY 1

### Method

*Sample.* The original field test involved a pre- and posttest with a single sample of community college ABE students. Pretesting occurred during the first week and posttesting during the last week of an academic quarter. Seventy-nine students, 55 males (70%) and 24 females (30%), enrolled in Adult Basic Education (ABE) classes at four North Carolina Community Colleges, participated in the program. Treatment lasted the duration of a 11-week quarter with direct instruction approximating 44 to 66 hours. Ethnically, 23 subjects were White (29%), 44 were Black (56%), and 12 were Other minorities (15%). These other minorities–Hispanics, Asians, and American Indians–were combined into a single demographic category for data analysis.

*Instrumentation.* Reading test scores were based on the Reading/Language subtest of the McGraw-Hill Tests of Adult Basic Educa-

tion (TABE), including Vocabulary, Comprehension, and Total Reading. According to the TABE Technical Report (CTB/McGraw Hill, 1987), procedures were used to control for bias, and standard item analysis was used to select items for the four levels and two forms of the test. Reliability for the TABE is .68 for the complete battery based on a sample of 8,125 subjects from 35 states and 95 different educational institutions. KR20 internal consistency reliability correlations ranged between .86 and .93 on tests of reading vocabulary and comprehension for the Adult Basic Education norm group using all forms and levels of the TABE. Concurrent validity was estimated by correlations between the TABE and General Education Development tests (GED) for 678 adult subjects. These correlations ranged from .42 to .64 (all had $p < .001$).

## Results

Table 1 shows mean Grade Equivalent (GE) gains for each sex and racial group. Concerning vocabulary, each group averaged more than one school year (GE) gain on the TABE. Other minorities (Hispanics, Asians, American Indians) had the largest GE mean gain of 1.44 school years, followed by Males, who averaged 1.36 school years gained. The Caucasian group had the smallest mean vocabulary gain of 1.11 GEs.

Concerning reading comprehension, the sample averaged nearly one and one-third school years' (GE) gain on the TABE. Again, the group of Other minorities had the largest GE comprehension mean gain of 1.67 school years, followed by Males, who averaged 1.59 school years gained. The smallest vocabulary gains were made by the group of Caucasians,who averaged only .53 GEs.

Finally, each sex and ethnic group averaged more than one school year (GE) gain on the Total Reading section of the TABE. Black students had the largest GE mean gain of 1.57 school years followed by Males, who averaged 1.50 school years. The smallest total gains were made by the Caucasians, who averaged 1.10 school years.

## Discussion

The pattern of consistent gains in vocabulary and reading comprehension for every demographic group suggests that the READY

TABLE 1
Single Course Gains on TABE Grade Equivalent (GE) Scores.

| | | | Vocabulary | | Comprehension | | Total Reading | |
|---|---|---|---|---|---|---|---|---|
| | | *n* | Mean | *SD* | Mean | *SD* | Mean | *SD* |
| Sample | | 79 | 1.18 | 1.5 | 1.31 | 1.6 | 1.40 | 1.3 |
| Race | | | | | | | | |
| | Caucasian | 22 | 1.11 | 1.7 | .53 | 1.7 | 1.10 | .9 |
| | Black | 42 | 1.12 | 1.6 | 1.57 | 1.6 | 1.57 | 1.5 |
| | Other | 15 | 1.44 | .9 | 1.67 | 1.0 | 1.42 | .8 |
| Sex | | | | | | | | |
| | Male | 22 | 1.36 | 1.8 | 1.59 | 1.3 | 1.50 | 1.3 |
| | Female | 57 | 1.12 | 1.4 | 1.21 | 1.7 | 1.36 | 1.3 |

Course provides effective reading instruction for low literate adults. Each group gained an average of more than one year in reading progress during a relatively short duration of 11 weeks. At the same time, however, the single sample design of Study 1 does not allow for robust conclusions. It is not known, for example, whether the gains made by these groups are solely attributable to the READY Course or to extraneous activities which might have engaged students' attention. In order to further clarity possible conclusions, a subsequent study was conducted which incorporated a research design using both experimental and control groups. Formative evaluation information collected from Study 1 was used to make modifications in screen design, functions available to students and instructors, and the development of an embedded reading diagnostic test. The diagnostic test development was the result of problems that developed in securing test information from the field test sites. In the use of this new technology, directors of the field test sites wanted to put the majority of their students in the experimental group. In addition, they had employed paper-pencil tests and manual record keeping of demographics and test information. This pro-

cess resulted in incomparable data sets due to incomplete information from multiple sites. The use of the reading tests embedded in the courseware greatly increased the number of complete data sets that could be used for analysis in the second study. Once revisions were completed using the formative information, a second field test was conducted.

## STUDY 2

### Method

*Sample*

Subjects for this study were 488 Adult Basic Literacy Education (ABLE) student volunteers at seven community colleges in North Carolina who were pursuing the General Education Development Diploma (GED). While only three community college sites were adequately equipped to run the experimental READY Course, all seven sites provided comparable test scores from participants in traditional reading instruction programs.

At the three READY Course sites, participants were randomly placed into experimental and control groups. Participants at the other four sites were assigned to control groups. Experimental groups (N = 238) received reading instruction using the READY Course delivered on CD-ROM over an 11-week academic quarter. Instructional time for the experimental group approximated 44 to 66 contact hours. Control groups received traditional Adult Basic Education reading instruction using instructional materials such as workbooks, low level-high interest reading materials, and conventional classroom instruction. Pretesting occurred for both groups before instruction began, and posttesting took place at the end of the 11-week period.

Once control group data were returned to the project evaluators, 250 control group subjects were randomly selected to match the percentage composition of the experimental group (n = 238) on the basis of ethnicity and sex. This technique produced the following experimental and control group distributions for ethnicity: Experimental–Caucasians (37%), Blacks (53%), Hispanics (5%), Asians

(3%); Control–Caucasians (38%); Blacks (53%); Hispanics (5%); and Asians (3%). At the same time, males constituted 44% of both experimental and control groups, while females constituted 56%.

*Instrumentation*

The community colleges participating in Study 2 all use the CTB McGraw-Hill Tests of Adult Basic Education (TABE) to diagnose and place students for instructional purposes. Consequently, as in Study 1, the TABE was used to determine reading improvement in terms of Grade Equivalent (GE) score. Due to different site procedures among the seven community colleges providing test data, the only comparable reading data among all subjects were Grade Equivalent scores on the Total Reading portion of the TABE.

## Results

Davis (1964) and Sax (1980) have demonstrated that GE scores represent ordinal level measurement. Consequently, to determine the equivalence of the matched experimental and control groups prior to the onset of reading instruction, a Mann-Whitney U test was conducted on pretest TABE Total Reading scores. The result, expressed as a $z$ score conversion of U, was 1.62 (two tailed $p < .11$), indicating that the two groups began their respective reading programs with equivalent reading abilities.

Based on information provided by individual subjects, no pretest differences were found in GE reading score gains as a function of age, gender, or previous reading instruction. Table 2 contains descriptive statistics of total reading GE gains for the sample, subdivided by experimental and control groups, ethnicity, and sex. The experimental group gained a mean GE Total Reading score of 20 months with a standard error of measurement of slightly less than one month. In comparison, the control group gained a mean of only six and one-half months, with a standard error of measurement also slightly less than one month. This difference was statistically significant ($z = 9.685$, 2-tailed $p < .0001$).

To test for differences between ethnic groups, a Kruskal-Wallis One-Way Analysis of Variance was conducted separately on the experimental and control subjects' GE gains for total reading. With

TABLE 2
Experimental and Control Group Mean Grade Equivalent (GE) Gains for TABE Total Reading Scores.

| | | EXPERIMENTAL | | | CONTROL | | |
|---|---|---|---|---|---|---|---|
| | | Mean | *SD* | *n* | Mean | *SD* | *n* |
| Sample | | 1.84 | 1.46 | 238 | .59 | 1.10 | 250 |
| Race | | | | | | | |
| | Caucasian | 1.50 | 1.46 | 87 | .70 | 1.19 | 95 |
| | Blacks | 1.99 | 1.43 | 128 | .48 | 1.05 | 132 |
| | Hispanic | 2.65 | 1.36 | 12 | 1.03 | .69 | 12 |
| | Asian | | | 8 | | | 8 |
| Sex | | | | | | | |
| | Male | 1.61 | 1.36 | 104 | .63 | 1.28 | 109 |
| | Female | 1.96 | 1.50 | 134 | .66 | 1.13 | 140 |

large samples, the test statistic H is approximately distributed as chi-square (Siegel, 1956). For the experimental group, Hispanics and Blacks showed greater gains than Caucasians and Asians (chi-square corrected for ties = 13.30, $df = 2$, $p < .005$). In contrast, control group Hispanics and Asians outgained Caucasians and Blacks (chi-square corrected for ties = 14.64, $df = 2$, $p < .003$).

It could be argued that experimental group gains could have been due to a relatively small number of students who, due to special motivation, completed more READY Course reading units than less motivated students. To test this line of reasoning, experimental subjects were divided into three groups as follows: (a) subjects who completed less than one unit, (b) those who completed between one and three units, and (c) those who completed more than three units. The Kruskal-Wallis test was used to compare these three groups, and it revealed that the greatest gains took place for those subjects who had completed more than one READY Course unit. The gains for those completing one to three READY Course units was about

the same as those who had completed four to six READY Course units, and these were both significantly higher than for students completing less than one READY Course unit (chi-square = 22.69, $df = 2, p < .0001$).

Table 3 displays pre- to posttest reading gains for the experimental group by pretest reading level. For experimental group subjects who were identified as LOW READERS, or those who had GE scores on the pretest below sixth grade level (6.0 and below), 112 of the 119 subjects showed gains in reading, 4 showed loses, and 3 did not change from pre- to posttest. The $z$ of 9.20 indicates a significant difference in reading gains for this group. Similarly, for experimental group subjects who were identified as HIGH READERS, or those who had GE scores on the pretest at or above sixth grade level (6.1 and above), 108 of the 119 subjects showed gains in reading, seven showed loses, and four did not change from pro to posttest. The $z$ of 8.84 also indicates a significant difference in reading gains for this group.

Table 4 displays experimental group reading gains by pretest reading level for both LOW and HIGH READERS. Based on the $z$ of $-1.2424$, there were no significant differences between the reading gains of LOW and HIGH READERS in the experimental group. Given the information in Table 4, there were significant gains for the LOW and for the HIGH READERS.

Table 5 displays information on the nature of experimental group reading gains based on the number of READY Course units completed. There were significant differences in reading gains based on the number of ready units completed. The greatest gains took place for those subjects who had completed more than one READY Course unit. The gains for those completing one to three READY Course units was about the same as for those who had completed four to six READY Course units.

The results of a Kruskal-Wallis One-Way Analysis of Variance of the experimental and control groups for pre- to posttest reading gain scores by previous ABE reading instruction indicated there were no significant differences between groups based on previous reading instruction.

TABLE 3
Wilcoxon Matched-Pairs Signed-Ranks Test for Experimental Group Pretest to Posttest Gains by Pretest Reading Level.

Experimental Group < Sixth-Grade Reading Level on the Pretest (Low Readers)

| Mean Rank | *n* | Wilcoxon Matched-Pairs Test[a] |
|---|---|---|
| 13.25 | 4 | − Ranks |
| 60.12 | 112 | + Ranks |
| | 3 | Ties |
| | --- | |
| | 119 Total | |

$z = -9.2014$ 2-Tailed $p < .0001$

Experimental Group ≥ Sixth-Grade Reading Level on the Pretest (High Readers)

| Mean Rank | *n* | Wilcoxon Matched-Pairs Test |
|---|---|---|
| 24.14 | 7 | − Ranks |
| 60.19 | 108 | + Ranks |
| | 4 | Ties |
| | --- | |
| | 119 Total | |

$z = -8.8355$ 2-Tailed $p < .0001$

a = − ranks indicate posttest lower than pretest scores
+ ranks indicate posttest higher than pretest scores

## Discussion

In the overall comparison, interactive reading courseware in the form of the READY Course far surpassed traditional reading instruction for virtually every identifiable group of low-literate

TABLE 4
Mann-Whitney U Test of Experimental Group Reading Gains by Pretest Reading Level for Low and High Readers.

| Reading Gain | | |
|---|---|---|
| Mean Rank | *n* | Mann-Whitney U - Wilcoxon Rank Sum W Test |
| 125.04 | 119 | Low Readers (< Sixth-Grade) |
| 113.96 | 119 | High Readers (≥ Sixth-Grade) |

| | | | Corrected for Ties |
|---|---|---|---|
| *u* | *w* | *z* | 2-Tailed *p* |
| 6421.0 | 14880.0 | −1.2424 | .2141 |

TABLE 5
Kruskal-Wallis One-Way ANOVA for Experimental Group Pre- to Posttest Gain Scores by Number of Ready Units Completed.

| Experimental Group | | |
|---|---|---|
| Mean Rank | *n* | |
| 101.26 | 137 | Less than one unit completed |
| 144.10 | 69 | One to three units completed |
| 144.56 | 32 | Four to six units completed |

| | | | Corrected for Ties | |
|---|---|---|---|---|
| *n* | Chi-Square | *p*< | Chi-Square | *p*< |
| 238 | 22.6708 | .0001 | 22.6926 | .0001 |

adults in the study. Future research should focus on the use of such interactive technology to train or instruct other groups from preschool through graduate school.

1. There were significant differences in pre- to posttest GE score gains by race (see Table 2). For the experimental group, Hispanics and Blacks showed the greatest gains. For the control

group, Blacks showed the lowest gain while Hispanics and Asians as well as whites showed the greatest gains. Both methods of instruction produced significant gains overall. The READY Reading course seemed to influence the gains in the Black population more than ABE reading instruction. These results tend to confirm earlier findings (Gretes & Songer, 1989) which suggest that Blacks see themselves as auditory learners.

2. There were scant differences in pre- to posttest GE score gains by number of READY Reading units completed (see Tables). The greatest gains took place once the subjects in the experimental group had completed one to three READY units and continued as they completed four to six units. This would suggest that students will need to complete more than one READY unit before significant gains in GE scores can be expected.
3. There were significant differences in pre- to posttest GE score gains by group (see Table 2). The average GE score gain for the experimental group was 1.8 school years over the 11-week instructional period. The average GE score gain for the control group was .59 school years over the 11-week instructional period. Based on these findings, the READY Course seems to produce much greater GE reading score gains than traditional instruction. Although both groups had significant gains over the 11-week instructional period, the experimental group experienced much greater GE reading score gains.
4. There were scant differences in pre- to posttest GE score gains by both the $<$ sixth-grade and $\geq$ sixth-grade experimental group subjects based on their pretest TABE scores (see Tables 3 and 4). Of the 119 subjects in the experimental group who scored below the sixth-grade reading level on the pretest, 112 showed gains from pre- to posttesting. Of the 119 subjects in the experimental group who scored above the sixth grade reading level on the pretest, 108 showed gains from pre- to posttesting. Based on these findings, significant gains were made by both those who were below the sixth-grade reading level on the pretest and also for those who were above the

sixth-grade reading level on the pretest. Pretest GE reading score did not seem to be a factor in the pre- to posttest gains.

5. There were no significant differences in GE reading score gains based on age, sex, or previous reading instruction.

The two studies reported here overcome certain limitations reported by Rachal (1993) with studies of CAI effectiveness with adult learners. Specifically, the sample sizes, use of pre- and posttesting, the quasi-experimental design of Study 2, and the replication of effects provide more robust conclusions about the READY Course than has been reported in other studies attempting to measure similar effects.

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